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PENSOFT

Floristic survey of the Furnas Gêmeas region, Campos Gerais National Park, Paraná state, southern Brazil

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Abstract
To investigate the resilience of the grassland flora of the Campos Gerais phytogeographic zone, this study surveys the phanerogamic plant species occurring in the Furnas Gêmeas area (Campos Gerais National Park, Paraná state, southern Brazil), especially those resilient to fragmentation by crops and fire. Collections were made monthly from October 2002 to May 2004 and occasionally from 2005 to 2013. In total, 313 species belonging to 70 angiosperms families and 2 gymnosperm families were collected. Just 4 angiosperm taxa were not determined to species. Although the Furnas Gêmeas has suffered from very evident anthropogenic changes, the vegetation retains part of its original richness, as seen in better-preserved areas outside the park. Included in our list are endangered species that need urgent measures for their conservation.

Key words
Paraná Flora; grassland; remaining natural vegetation; resilient species; Campos Gerais phytogeographic zone

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Introduction

In Paraná state, Brazil, in the phytogeographic zone known as Campos Gerais (Maack 1948), there are several natural round depressions formed by sandstone collapse, the *furnas*, which specifically occur in outcrop areas of the Furnas Formation in the intracratonic Paraná Basin (Soares 1989). These depressions generally have water or dense vegetation inside (Soares 1989) and above them occurs natural grassland vegetation in a mosaic with *Araucaria* temperate forest patches. Among the 14 known *furnas* in the Campos Gerais region (Soares 1989), 3 are within Campos Gerais National Park (CGNP).

The Campos Gerais native vegetation is threatened by its intense replacement to crops or pine plantations (Ziller 2000, Melo et al. 2007), which prevent native grasses from surviving and can lead to degradation of fragile soils (Pillar 2006, Dalazoana 2010). Thus, the Brazilian government has considered the region conservation as priority (MMA 2007).

Studies in the Campos Gerais phytogeographic zone have shown a high species richness that includes rare and endangered species (Cervi et al. 2007, Nanuncio and Moro 2008, Dalazoana 2010, Ritter et al. 2010, Andrade et al. 2011, Mioduski and Moro 2011, Carmo et al. 2012, Carmo and Assis 2012, Moro et al. 2012). However, all of these studies were undertaken in relatively well-

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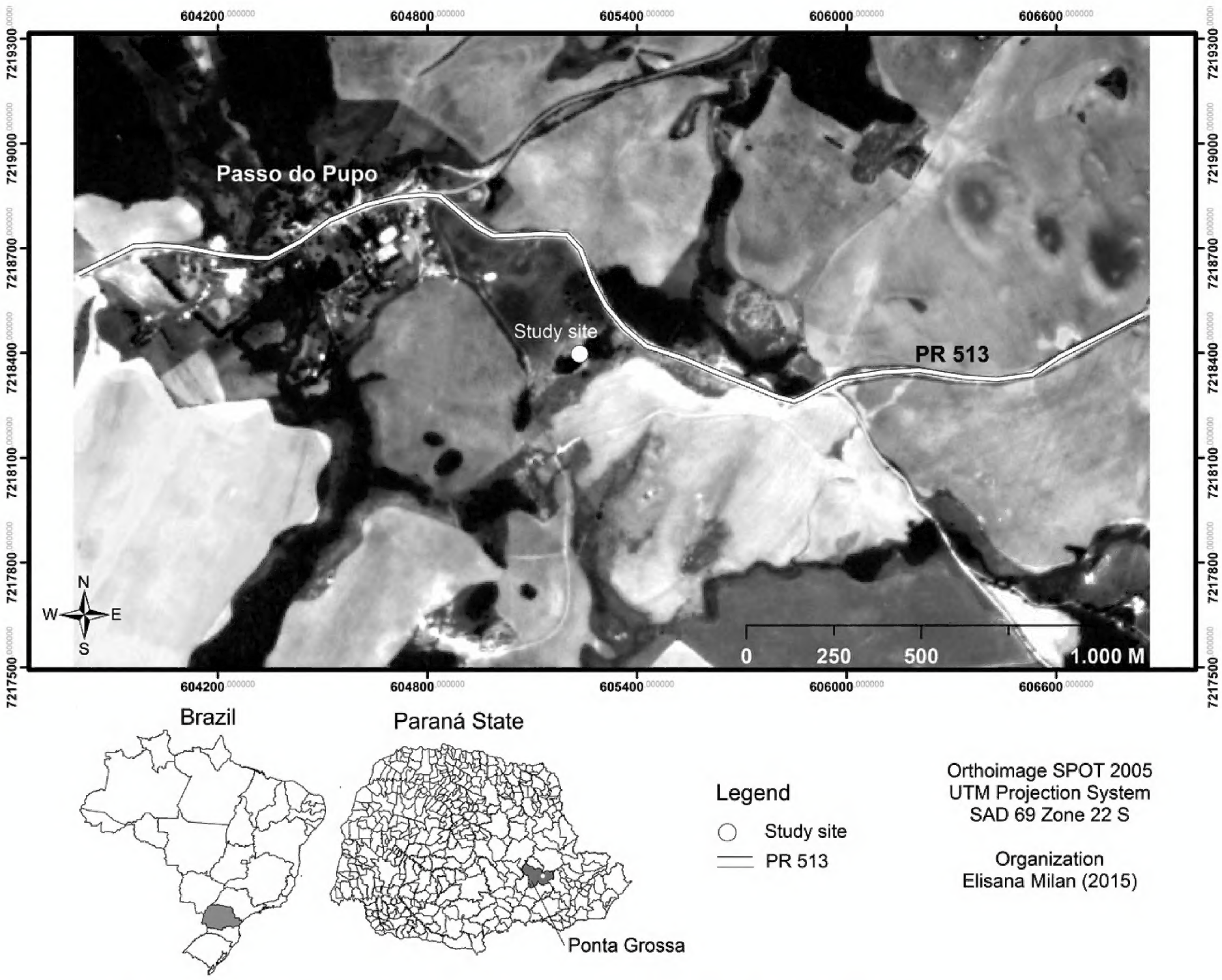


Figure 1. Location of the study site in Furnas Gêmeas, Campos Gerais National Park, Paraná state, Brazil.

preserved landscapes. In impacted areas, the flora is little known, and thus, an assessment of species resilience to anthropogenic changes is required.

We choose an area in the CGNP that has undergone anthropogenic changes, including annual cropping, burning, and development for recreation (hiking routes). Even so, the Furnas Gêmeas site still preserves much of its native vegetation. We investigated the presence of resilient species by comparing the Furnas Gêmeas floristic list to those of four more intact areas outside of the CGNP, which we considered reference areas.

Methods

Study site. With an area of 21,500 ha, CGNP is located in the municipalities of Ponta Grossa, Castro, and Carambeí, Paraná, southern Brazil. This national park was created in March 2006 with the aim to preserve some of the last remnants of natural grasslands and their rich flora and fauna. These grasslands were traditionally exploited for livestock, but in recent decades, they are being replaced by crops and pine plantations (Brasil 2008).

We conducted the study at Furnas Gêmeas (FG) in CGNP (Fig. 1), that comprises 2 caves, 22 km away from Ponta Grossa (25°08′46″ S, 049°057′025″ W) (SAD69).

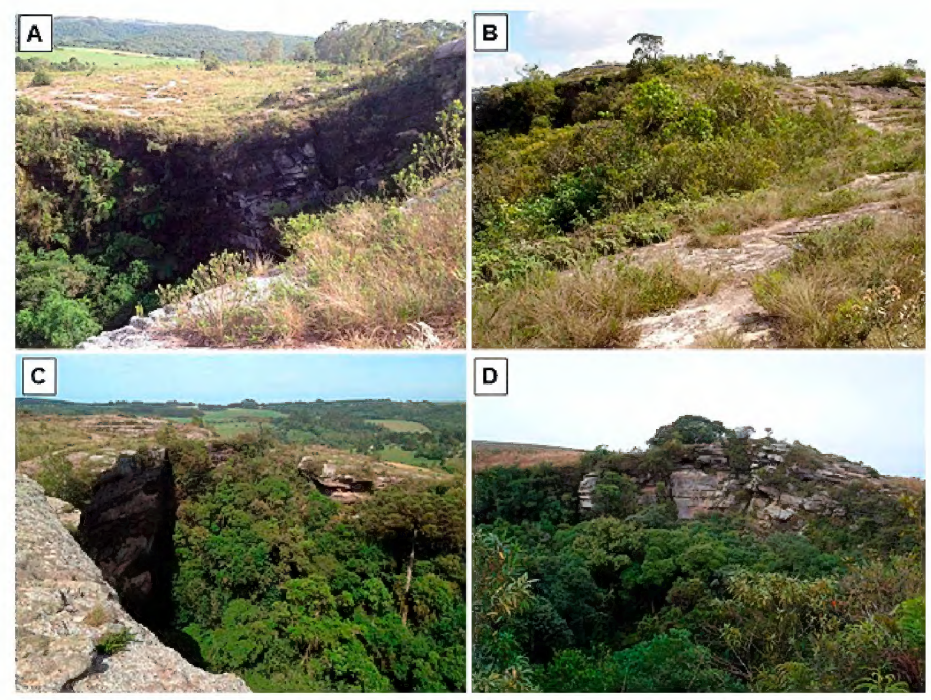


Figure 2. The insides and surroundings of the furnas. **A, B.** Furna 1. **C, D.** Furna 2.

Furna 1 (80 m wide × 50 m deep) and Furna 2 (17 m wide × 53 m deep) are separated by a small 60–100 m strip of land (Soares 1989). Trees that are typical of Araucaria forest occur inside of these furnas; outside of them, grassland vegetation prevails among the outcrops of sandstone (Fig. 2).

The climate of CGNP is Cfb (Altitudinal Subtropical Humid) according to the Koeppen classification, with a

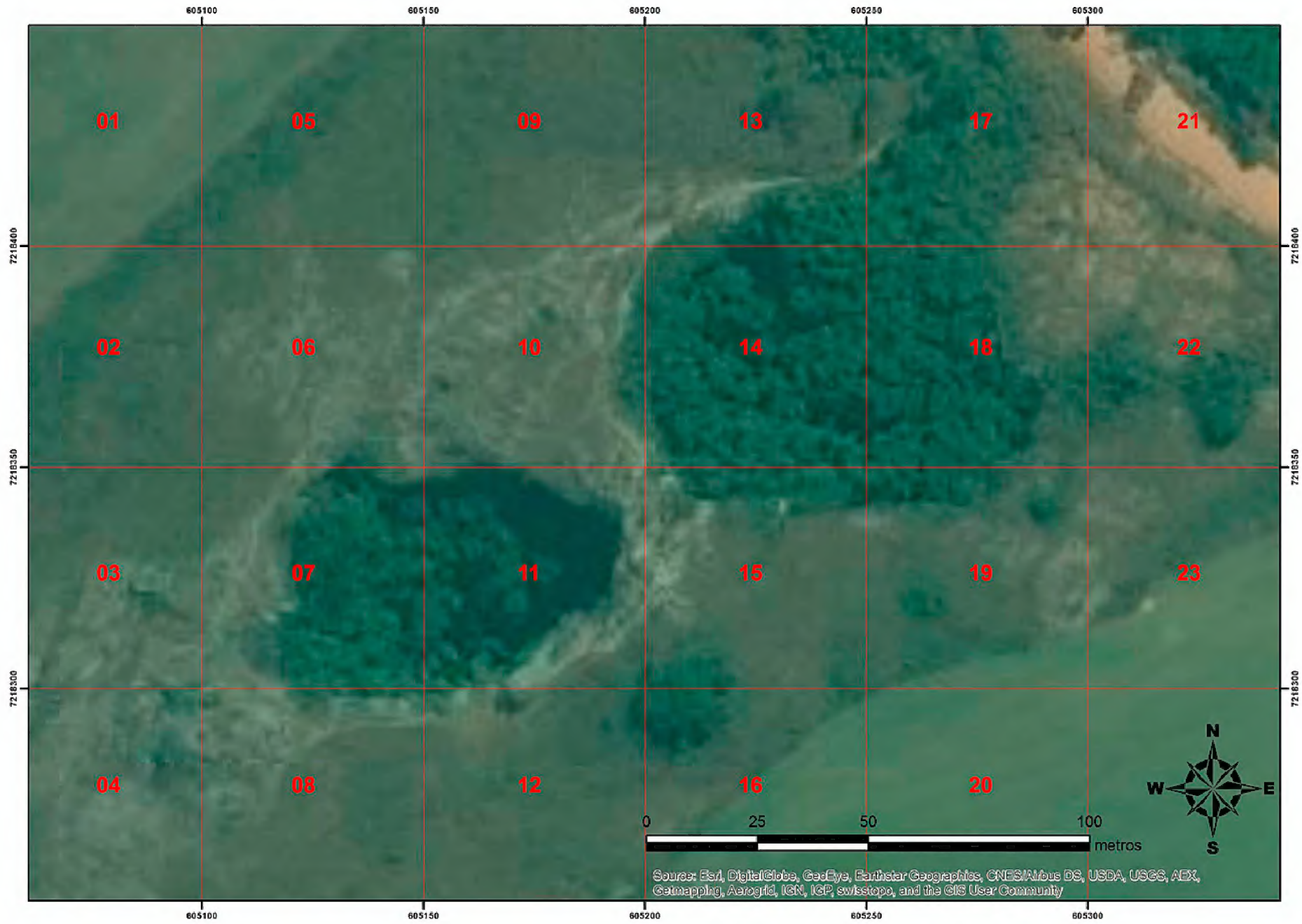


Figure 3. The 50 × 50 m grid to locate the species sampled in *Furnas Gêmeas*, *Campos Gerais* National Park, Paraná state, Brazil.

mean annual temperature of 17.6 °C (range: 16–22 °C; Cruz 2007).

According Embrapa (2008), the shallow young soils are mainly lithosols (*Neossolos litólicos*), regosols (*Neossolos Regolíticos*), and haplic cambisols (*Cambissolos háplicos*), with frequent rocky outcrops that are very susceptible to erosion (Melo et al. 2007). Until the 1970s, the main economic activity in the region was cattle ranching on native grasslands, but crops under no-tillage system have replaced ranching. More recently, monocultures of pine have been planted on most non-farmable land (Ziller 2000).

Data collection. In order to record plants in a spatial scale we used a 50 × 50 m grid, placed over an aerial image of the study area, using ArcGIS 10.3 and the basemap of the ArcGIS Online (Fig. 3). We visited the study area monthly from October 2002 to May 2004 (totaling 20 months), and sporadically from 2005 to 2013, collecting phanerogamic plant specimens in their reproductive state.

We follow the standard procedures for preparing botanic material (Fidalgo and Bononi 1984) and deposited vouchers in the HUPG herbarium. Identifications were made by consulting the literature and collections of the HUPG, MBM and UPCB herbaria (acronyms according to Thiers 2016).

The taxonomic classification of angiosperms follows APG IV (2016), and of gymnosperms, Bowe et al. (2000). Species and author names are in accordance to *The International Plant Names Index* (IPNI). Taxa were classified according to:

(1) Life-forms (following Raunkiaer 1934, adapted by Mueller-Dombois and Ellenberg 1974): chamaephyte, geophyte, hemicryptophyte, phanerophyte, therophyte, liana, epiphyte, and parasite.
(2) Dispersion syndrome (following morphological criteria proposed by van der Pijl 1982): zoochoric, anemochoric, autochoric, and unknown.
(3) Invasion status (following Pyšek et al. 2004): native, alien species, casual alien, naturalized, invasive, and transformers. Transformers are defined as a subset of invasive plants, not necessarily alien, that change the character, condition, form, or nature of ecosystems.

We checked the presence of threatened species according to the *Lista Oficial das Espécies da Flora Brasileira Ameaçadas de Extinção* (MMA 2014) and the *Lista vermelha de plantas ameaçadas de extinção no estado do Paraná* (Paraná 1995).

We compared the similarity of the flora of Furnas Gêmeas with well-preserved neighboring areas, based on published studies (Guartelá State Park: Carmo 2006; Vila Velha State Park, Cervi et al. 2007; Piraí da Serra, Nanuncio and Moro 2008; Pitangui Valley, Moro et al. 2012). We employed a 1782-species presence/absence matrix using Cluster Analysis (Ward's distance).

Table 1. Species in the Furnas Gêmeas, Campos Gerais National Park (CGNP), Paraná state, Brazil. L-F= Raunkiaer's life-forms, Ch = chamaephyte, G = geophyte, H = hemicryptophyte, Ph = phanerophyte, Th = therophyte, L = liana, E = epiphyte, P = parasite, DS = Dispersal syndrome, Ane = anemochoric, Zoo = zoochoric, Aut = autochoric, Unk = unknown, * = species identified based on non-fertile specimens, Collector = number of collector MRBC, C = category of species (invasive and endangered status), Na = native, Al = alien species, We = weed, In = invasive, Tr = transformers, EV = endangered species-vulnerable, ER = endangered species-rare, CG = endemic specie in the *Campos Gerais*, Location (related to square number shown in Figure 3).

Families, species	L-F	DS	Voucher	Coll.	C	Location	Reference
Araucariaceae							
Araucaria angustifolia (Bertol.) Kuntze	Ph	Zoo	21,506	1871	Na, EV	7	Garcia 2002
Pinaceae							
Pinus elliottii Engelm.	Ph	Ane	21,507	1870	Al, In	21	Marchiori 1996
Acanthaceae							
Dyschoriste hygrophiloides (Ness) Kuntze	G	Aut	13,918	1302	Na	09/10	Silva 2011
Ruellia multifolia (Nees) Lindau	G	Aut	17,764	1608	Na, ER	10	Silva 2011
Amaranthaceae							
Alternanthera brasiliana (L.) Kuntze	G	Aut	17,149	31	Na, Tr	10	Siqueira 2002, Senna 2015
Pfaffia gnaphaloides (L.f.) Mart.	G	Aut	17,145	1260	Na	19	Marchioretto et al.2010
Pfaffia tuberosa (Spreng.) Hicken	G	Aut	17,141	1619	Na	10	Marchioretto et al.2010
Amaranthaceae sp.	G	Aut	21,257	1848	Na	10	-
Amaryllidaceae							
Hippeastrum psittacinum Herb.	G	Aut	14,733	1232	Na	13	Dutilh 2005
Nothoscordum gracile (Aiton) Stearn	G	Aut	14,516	19	Na, We	10	Dutilh 2005, Moreira and Bragança 2011
Anacardiaceae							
Schinus terebinthifolius Raddi	Ph	Zoo	13,915	1559	Na	17	Luz 2011
Schinus weinmannifolius Engl.	Ph	Zoo	13,914	1648	Na	21	Luz 2011
Annonaceae							
Guatteria australis A.St.-Hil.	Ph	Zoo	*	-	Na	21	Lobão et al.2012
Apiaceae							
Eryngium elegans Cham. & Schltdl.	H	Aut	13,910	70	Na, Tr	15	Corrêa and Pirani 2005
Eryngium horridum Malme	H	Aut	13,911	1347	Na, Tr	19	Corrêa and Pirani 2005, Cota 2009
Eryngium pristis Cham. & Schltdl.	H	Aut	13,908	1459	Na	11	Corrêa and Pirani 2005, Cota 2009
Apocynaceae							
Ditassa edmundoi Fontella & Valente	L	Ane	17,140	1458	Na	11	Koch et al.2015
Mandevilla atroviolacea (Stadelm.) Woodson	L	Ane	13,906	93	Na	17	Sales 1993, Matozinhos and Konno 2011
Mandevilla coccinea (Hook. & Arn.) Woodson	G	Ane	*	-	Na, ER	09	Sales 1993, Sales and Kinoshita 2005
Mandevilla pohliana (Stadelm.) A.H.Gentry	H	Ane	13,901	76	Na	13	Sales 1993, Sales and Kinoshita 2005
Oxypetalum sp.	L	Ane	13,903	1435	Na	10	-
Aquifoliaceae							
Ilex theezans Mart. ex Reissek	Ph	Zoo	13,900	1404	Na	15	Brotto et al. 2007
Araliaceae							
Schefflera macrocarpa (Cham. & Schltdl.) Frodin	Ph	Zoo	13,899	1282	Na	22	Fiaschi et al. 2007
Arecaceae							
Allagoptera campestris (Mart.) Kuntze	G	Zoo	14,603	1236	Na	19	Caxambú et al. 2015
Syagrus romanzoffiana (Cham.) Glassman	Ph	Zoo	*	-	Na	22	Caxambú et al. 2015
Asteraceae							
Achyrocline satureioides (Lam.) DC.	Ch	Ane	14,001	1723	Na, Tr	09/10/13	Moraes 1997, Hattori and Nakajima 2008
Aspilia montevidensis (Spreng.) Kuntze	Ch	Ane	14,039	1263	Na	15	Santos 1984
Baccharis axillaris DC.	Ch	Ane	17,157	1230	Na	10/13	Oliveira and Marchiori 2006b
Baccharis calvescens DC.	Ch	Ane	17,207	1639	Na	08	Hattori and Nakajima 2008
Baccharis coridifolia DC.	G	Ane	14,035	1701	Na, Tr	10	Fagundes et al. 2015
Baccharis crispa Spreng.	Ch	Ane	14,047	1702	Na, Tr	13	Moraes 1997, Hattori and Nakajima 2008, Heiden et al. 2009
Baccharis dracunculifolia DC.	H	Ane	14,034	1198	Na, Tr	17	Moraes 1997, Hattori and Nakajima 2008
Baccharis linearifolia (Lam.) Pers.	Ch	Ane	17,156	1163	Na	10/13	Hattori and Nakajima 2008
Baccharis montana DC.	Ch	Ane	17,176	1633	Na	21	Barroso 1957
Baccharis oblongifolia (Ruiz & Pav.) Pers.	Ch	Ane	14,068	1185	Na	13	Oliveira and Marchiori 2005
Baccharis pentodonta Malme	H	Ane	17,154	1703	Na	10	Oliveira and Marchiori 2006a, Fernandes and Ritter 2009
Baccharis punctulata DC.	Ch	Ane	14,069	1714	Na	10	Moraes 1997, Fernandes and Ritter 2009, Heiden et al. 2012
Baccharis tarchonanthoides DC.	Ch	Ane	17,198	81	Na	10	Barroso 1957
Baccharis vulneraria Baker	Ch	Ane	14,759	1251	Na	21	Heiden et al. 2012
Calea cuneifolia DC.	H	Ane	17,161	8	Na	10/13	Mondin et al. 2015
Calea parvifolia (DC.) Baker	H	Ane	18,916	1770	Na	10	Pruski 2005
Chaptalia integerrima (Vell.) Burkart	Ch	Ane	17,173	1333	Na, We	13	Hattori and Nakajima 2008, Pasini et al. 2014
Chromolaena hirsuta (Hook. & Arn.) R.M.King & H.Rob.	Ch	Ane	18,918	1778	Na	10/13	Esteves 2001

Table 1. *Continued.*

Families, species	L-F	DS	Voucher	Coll.	C	Location	Reference
Chromolaena palmaris (Sch.Bip. ex Baker) R.M.King & H.Rob.	Ch	Ane	17,481	1547	Na	10	Cabrera and Klein 1980
Chrysolaena platensis (Spreng.) H.Rob.	Ch	Ane	14,042	1705	Na, Tr	10	Barroso 1957, Soares 2012
Chrysolaena simplex (Less.) Dematt.	Ch	Ane	17,211	14	Na	10	Hattori and Nakajima 2008, Soares 2012
Cirsium vulgare (Savi) Ten.	Th	Ane	19,696	1849	Al, In	10	Lorenzi 2008
Conyza bonariensis (L.) Cronquist	H	Ane	14,073	1509	Na, We	10	Hattori and Nakajima 2008
Disynaphia filifolia (Hassl.) R.M.King & H.Rob.	Ch	Ane	14,863	1529	Na	10	King and Robinson 1971
Elephantopus mollis Kunth	Ch	Ane	14,830	1197	Na, We	10	Moraes 1997, Hattori and Nakajima 2008
Gamochaeta falcata (Lam.) Cabrera	Ch	Ane	19,738	1850	Na	10	Deble and Marchiori 2007
Gamochaeta purpurea (L.) Cabrera	Ch	Ane	19,697	1851	Na, In	06/10/13	Barroso 1957, Deble and Marchiori 2007
Gochnatia polymorpha (Less.) Cabrera	Ph	Ane	14,071	1242	Na	04/14	Fernandes and Ritter 2009
Grazielia multifida (DC.) R.M.King & H.Rob.	H	Ane	13,998	1476	Na	06/10/13	Esteves 2001
Gyptis pinnatifita Cass.	Ch	Ane	6,620	79	Na	10	Esteves 2001
Inulopsis scaposa (DC.) O.Hoffm.	H	Ane	14,032	1233	Na	10/13	Barroso 1957
Lessingianthus brevifolius (Less.) H.Rob	Ch	Ane	17,169	1421	Na	10	Fagundes et al. 2015
Lessingianthus intermedius (DC.) Dematt	Ch	Ane	17,166	1499	Na	10	Beretta et al. 2008
Lucilia acutifolia (Poir) Cass.	Ch	Ane	17,188	1375	Na	13	Fagundes et al. 2015
Lucilia linearifolia Baker	Ch	Ane	18,919	1779	Na	13	Barroso 1957
Mikania banisteriae DC.	L	Ane	14,038	1519	Na	11	Ritter et al. 2015
Mikania hoffmanniana Dusén	L	Ane	14,788	1243	Na	04	Cabrera and Klein 1989
Mikania micrantha Kunth	L	Ane	17,287	89	Na	06/10	Moraes 1997, Ritter and Miotto 2005
Noticastrum calvatum (Baker) Cuatrec.	Ch	Ane	17,164	1700	Na	10/13	Beretta et al. 2008
Noticastrum sericeum (Less) Less ex Phil.	Ch	Ane	17,215	46	Na	13	Philippi 1864
Piptocarpha axillaris (Less.) Baker	Ph	Ane	14,005	1748	Na	17	Grokoviski et al. 2009
Piptocarpha regnellii (Sch. Bip.) Cabrera	Ch	Ane	17,172	1679	Na	17	Grokoviski et al. 2009
Pterocaulon angustifolium DC.	Ch	Ane	14,036	1490	Na	10/13	Lima and Matzenbacher 2008
Senecio brasiliensis (Spreng.) Less.	Th	Ane	14,066	1318	Na, We	22	Moraes 1997, Teles 2008, Oliveira et al. 2015
Senecio grisebachii Baker	Th	Ane	14,056	15	Na	10	Baker 1884
Senecio oleosus Vell.	Th	Ane	14,052	1170	Na	06	Teles 2008, Oliveira et al. 2015
Solidago chilensis Meyen	Th	Ane	17,201	1735	Na, We	10	Beretta et al. 2008
Stenocephalum megapotamicum (Spreng.) Sch. Bip.	Ch	Ane	17,175	1704	Na	10/13	Hattori and Nakajima 2008, Moreira and Teles 2014
Stevia sp. 1	Ch	Ane	14,037	1710	Na	10	-
Stevia sp. 2	Ch	Ane	18,674	1721	Na	10	-
Trixis nobilis (Vell.) Katinas	Ch	Ane	17,286	1510	Na	10/13	Fernandes and Ritter 2009
Vernonanthura crassa (Vell.) H.Rob.	Ch	Ane	14,070	1206	Na	13	Robinson 1992
Vernonanthura cuneifolia (Gardner) H.Rob.	Ch	Ane	17,170	1193	Na	10	Soares 2012
Vernonanthura nudiflora (Less) H.Rob	Ch	Ane	17,180	1564	Na, Tr	10	Cabrera and Klein 1989
Asteraceae sp. 1	Ch	Ane	17,214	16	Na	10	-
Asteraceae sp. 2	Ch	Ane	14,072	49	Na	10	-
Asteraceae sp. 3	Ch	Ane	17,216	1625	Na	10	-
Asteraceae sp. 4	Ch	Ane	17,574	1316	Na	19	-
Berberidaceae							
Berberis laurina Billb.	Ph	Zoo	17,387	1359	Na	22	Pedralli 2002
Bignoniaceae							
Amphilophium crucigerum (L.) L.G.Lohmann	L	Ane	17,137	1400	Na	04	Villagra and Romaniuc Neto 2011
Boraginaceae							
Moritzia dusenii I.M.Johnst.	H	Aut	14,598	21	Na	10	Ranga 2012
Bromeliaceae							
Aechmea bromeliifolia (Rudge) Baker	H	Zoo	14,762	11	Na	13	Santos and Wanderley 2012, Miyamoto 2013
Aechmea distichantha Lem.	H	Ane	18,076	1207	Na	13	Santos and Wanderley 2012, Miyamoto 2013
Dyckia deltoidea (L.B.Sm.) L.B.Sm.	H	Ane	18,530	20	Na	10	Ribas 2017
Tillandsia stricta Sol.	H	Ane	*	-	Na	10	Kremer 2011
Vriesea platynema Gaudich.	H	Ane	14,761	1183	Na	11	Kowalski and Tardivo 2015
Cactaceae							
Hatiora salicornioides (Haw.) Britton & Rose	H	Zoo	13,783	1522	Na	22	Soller et al. 2014
Parodia carambeiensis (Buining & Brederoo) Hofacker	H	Zoo	*	-	Na, CG	22	Soller et al. 2014
Campanulaceae							
Lobelia camporum Pohl	Ch	Aut	17,291	1460	Na	11	Vieira 1988, Godoy 2003
Wahlenbergia linarioides (Lam.) DC.	Ch	Aut	17,350	1600	Na, Tr	17	Godoy 2003
Caryophyllaceae							
Cerastium dicrotrichum Fenzl ex Rohrb.	Ch	Ane	14,770	33	Na	10	Carneiro 2015a
Spergularia grandis (Pers.) Cambess.	Th	Ane	18,077	78	Na	10	Carneiro 2015b
Celastraceae							
Maytenus evonymoides Reissek	Ph	Zoo	17,293	1677	Na	17	Carvalho-Okano 2005
Maytenus gonoclada Mart.	Ph	Zoo	14,822	1736	Na	17	Carvalho-Okano 2005

Table 1. *Continued.*

Families, species	L-F	DS	Voucher	Coll.	C	Location	Reference
Cistaceae							
Halimium brasiliense Grosser	Th	Ane	9,252	1305	Na, ER	10/19	Reitz 1988
Clethraceae							
Clethra scabra Pers.	Ph	Ane	14,604	1472	Na	22	Perdiz et al. 2015
Commelinaceae							
Commelina diffusa Burm.f	H	Aut	19,759	1852	Na, We	10	Maia 2006, Hassemer 2017
Commelina erecta L.	H	Aut	18,086	27	Na	10/13	Maia 2006, Hassemer 2017
Commelina villosa (C.B.Clarke) C.B.Clarke ex Chodat & Hassl.	H	Aut	18,084	1429	Na, We	10	Hassemer 2017
Tradescantia cerinthoides Kunth	H	Aut	18,083	97	Na	10	Aona et al. 2015, Funez et al. 2016
Tradescantia fluminensis Vell.	H	Aut	18,088	1224	Na, Tr	22	Barreto 2005, Funez et al. 2016
Convolvulaceae							
Cuscuta racemosa Mart.	P	Zoo	19,381	1861	Na, We	22	Hoehne 1922
Ipomoea delphinioides Choisy	L	Aut	18,091	44	Na	17	Ferreira and Miotto 2009
Cucurbitaceae							
Cayaponia martiana (Cogn.) Cogn.	L	Zoo	19,735	1853	Na	06	Villagra and Romaniuc Neto 2011
Cyperaceae							
Bulbostylis capillaris (L.) C.B.Clarke	H	Aut	17,629	1373	Na, We	12	Vitta and Prata 2009
Bulbostylis sp	H	Aut	17,618	1470	Na	10	-
Carex sellowiana Schltdl.	H	Aut	14,076	77	Na	06	Silva et al. 2009
Cyperus aggregatus (Willd.) Endl.	G	Aut	17,622	1707	Na	10	Hefler 2010
Cyperus esculentus L.	G	Aut	14,077	1364	Al, We	17	Moreira and Bragança 2011
Cyperus rigens C.Presl var. *rigens*	G	Aut	17,621	1462	Na	10	Hefler 2010
Eleocharis filiculmis Kunth	H	Aut	17,617	1361	Na	15/19	Trevisan and Boldrini 2008
Kyllinga brevifolia Rottb.	G	Aut	17,626	1436	Na, We	10	Gonçalves 2014
Rhynchospora setigera (Kunth) Boeckeler	H	Aut	17,627	17	Na	10	Silva et al. 2009
Scleria hirtella Sw.	G	Aut	17,620	88	Na	10	Silveira and Longhi-Wagner 2008
Droseraceae							
Drosera brevifolia Pursh	Th	Ane	14,826	1741	Na	8	Silva 2015
Ericaceae							
Agarista pulchella Cham. ex G.Don	Ph	Zoo	14,044	92	Na	10	Kinoshita and Romão 2012
Gaylussacia brasiliensis (Spreng.) Meisn. var. *brasiliensis*	Ph	Zoo	19,805	1862	Na	10	Romão 2011, Kinoshita and Romão 2012
Eriocaulaceae							
Actinocephalus polyanthus (Bong.) Sano	H	Aut	14,579	1457	Na	11	Sano and Trovó 2012
Paepalanthus caldensis Malme	H	Ane	14,580	1406	Na	15	Malme 1901
Erythroxylaceae							
Erythroxylum deciduum A.St.-Hil.	Ph	Zoo	14,584	1341	Na	22	Mendonça et al. 1998
Erythroxylum microphyllum A.St.-Hil.	Ph	Zoo	14,581	1410	Na	15/19	Mendonça et al. 1998
Erythroxylum suberosum A.St.-Hil.	Ph	Zoo	14,585	1340	Na	04/13	Mendonça et al. 1998
Euphorbiaceae							
Alchornea triplinervia (Spreng.) Müll.Arg.	Ph	Zoo	14,572	1392	Na	11/14	Secco and Giulietti 2004
Croton antisyphiliticus Mart.	Ch	Aut	14,575	5	Na	10	Sodré et al. 2014
Croton heterodoxus Baill.	Ch	Aut	9,265	1720	Na	10	Caruzo and Cordeiro 2007
Gymnanthes klotzschiana Müll.Arg.	Ph	Zoo	14,577	1286	Na	17	Pscheidt 2011
Gymnanthes schottiana Müll.Arg.	Ph	Aut	19,700	1667	Na	15	Pscheidt 2011
Pera glabrata (Schott) Poepp. ex Müll.Arg.	Ph	Zoo	9,258	1249	Na	17	Lucena et al. 2009
Sapium glandulosum (L.) Morong	Ph	Zoo	*	-	Na	22	Lucena et al. 2009, Pscheidt 2011
Fabaceae							
Aeschynomene falcata (Poir.) DC.	Ch	Zoo	18,135	1443	Na	10	Andrade 2009
Chamaecrista langsdorffii (Kunth ex Vogel) Britton ex Pittier	Ch	Aut	18,563	1511	Na	10	Souza and Silva 2015
Chamaecrista rotundifolia (Pers.) Greene var. *rotundifolia*	Th	Aut	18,561	1444	Na, Tr	10	Camargo and Miotto 2004, Dantas and Silva 2013
Crotalaria hilariana Benth.	Ch	Aut	18,139	1385	Na	13	Andrade 2009
Desmodium affine Schltdl.	Ch	Zoo	18,137	1432	Na	10	Snak et al. 2012
Desmodium incanum DC.	Ch	Zoo	18,146	60	Na, We	06/09/13	Andrade 2009
Eriosema campestre var. *macrophyllum* (Grear) Fortunato	H	Aut	18,140	16	Na	10	Andrade 2009
Eriosema heterophyllum Benth.	G	Aut	14,000	1715	Na	10	Andrade 2009, Rogalski 2009
Eriosema longifolium Benth.	G	Aut	18,144	1722	Na	10/13	Andrade 2009, Rogalski 2009
Galactia boavista (Vell.) Burkart	Ch	Aut	14,006	29	Na	13	Andrade 2009, Ceolin 2011
Leucochloron incuriale (Vell.) Barneby & J.W.Grimes	Ph	Aut	18,204	1452	Na	13	Tozzi 2016
Mimosa dolens var. *acerba* (Benth.) Barneby	Ch	Aut	18,206	1500	Na	10/15	Dutra 2009
Mimosa invisa Mart. ex Colla	Ch	Zoo	18,205	384	Na, Tr	10/13	Moreira and Bragança 2011, Tozzi 2016
Mimosa lanata Benth.	Ch	Aut	19,850	1854	Na	10	Dutra 2009, Tozzi 2016
Mimosa micropteris Benth. var. *micropteris*	Ch	Aut	18,202	1210	Na	06	Tozzi 2016
Mimosa paranapiacabae Barneby	Ch	Aut	18,196	39	Na	10	Tozzi 2016
Senna macranthera (DC. ex Collad.) H.S.Irwin & Barneby	Ph	Aut	18,564	1561	Na	17	Rodrigues et al. 2005
Stylosanthes guianensis (Aubl.) Sw.	H	Zoo	14,014	1713	Na, Tr	13	Andrade 2009

Table 1. *Continued.*

Families, species	L-F	DS	Voucher	Coll.	C	Location	Reference
Zornia reticulata Sm.	H	Zoo	14,017	1442	Na, Tr	10	Andrade 2009
Gesneriaceae							
Sinningia canescens (Mart.) Wiehler	G	Ane	14,528	83	Na	13	Chautems 2003
Gleicheniaceae							
Gleichenella pectinata (Willd.) Ching	G	Ane	21,508	1869	Na	13	Prado 2005
Hypericaceae							
Hypericum brasiliense Choisy	Ch	Ane	14,681	1530	Na	10	Slusarski et al. 2007
Hypericum ternum A.St.-Hil.	Ch	Ane	17,276	1322	Na	15	Slusarski et al. 2007
Hypoxidaceae							
Hypoxis decumbens L.	G	Aut	19,739	1863	Na, We	10/13	Dutilh 2005, Moreira and Bragança 2011
Iridaceae							
Sisyrinchium fasciculatum Klatt	G	Aut	14,779	13	Na, We	10	Chukr 2003
Sisyrinchium luzula Klotzsch ex Klatt	G	Aut	17,582	1864	Na	10	Chukr 2003
Sisyrinchium vaginatum Spreng.	G	Aut	14,820	1590	Na	10	Chukr 2003
Sisyrinchium wettsteinii Hand.- Mazz.	G	Aut	14,532	1276	Na	10	Chukr 2003
Lamiaceae							
Aegiphila verticillata Vell.	G	Zoo	18,851	1865	Na	17	Harley et al. 2015
Cantinoa plectranthoides (Benth.) Harley & J.F.B.Pastore	Ch	Aut	14,063	91	Na	10	Silva-Luz et al. 2012
Hyptis lappulacea Mart. ex Benth.	Ch	Aut	14,763	1609	Na	10	Leary 2015
Hyptis meridionalis Harley & J.F.B. Pastore	G	Aut	14,526	1306	Na	10	Harley and Pastore 2012
Peltodon longipes A.St.-Hil ex Benth.	G	Aut	15,312	1603	Na	10	Moreira and Bragança 2011
Salvia aliciae E.P.Santos	Ch	Aut	14,791	2	Na	13	Santos 1993
Lauraceae							
Cinnamomum sellowianum (Nees & Mart.) Kosterm.	Ph	Zoo	14,485	1175	Na	22	Baitello 2003
Nectandra grandiflora Nees	Ph	Zoo	14,478	1250	Na	21	Zanon et al. 2009
Ocotea pulchella (Nees & Mart.) Mez	Ph	Zoo	19,316	1866	Na	15/21	Brotto et al. 2009
Lauraceae sp. 1	Ph	Zoo	21,258	1680	Na	15	-
Lythraceae							
Cuphea calophylla subsp. *mesostemon* (Koehne) Lourteig	Ch	Aut	14,463	1565	Na	10	Facco 2015
Cuphea linifolia (A.St.-Hil.) Koehne	Ch	Aut	19,758	1419	Na	10	Facco 2015
Malpighiaceae							
Aspicarpa pulchella (Griseb.) O'Donell & Lourteig	G	Ane	14,767	15	Na	10	O'Donell and Lourteig 1943
Byrsonima brachybotrya Nied.	Ph	Zoo	13,485	1514	Na	13	Niedenzu 1897
Byrsonima intermedia A.Juss.	Ph	Zoo	16,539	1309	Na, Tr	15	Mamede 1987
Malvaceae							
Byttneria hatschbachii Cristóbal	Ch	Zoo	9,262	1611	Na	10	Cruz and Esteves 2009
Peltaea speciosa (Kunth) Standl.	G	Aut	14,775	1719	Na	21	Bovini 2015
Sida santaremensis Mont.	Ch	Aut	14,766	1338	Na, We	21	Bovini et al. 2001
Melastomataceae							
Lavoisiera pulchella Cham.	Ch	Zoo	14,445	1423	Na	15/19	Goldenberg et al. 2015
Leandra aurea Cogn.	Ch	Zoo	14,496	1235	Na	10	Camargo et al. 2009
Leandra lacunosa Cogn.	Ch	Zoo	14,499	1281	Na	10/13	Camargo et al. 2009
Leandra purpurascens (DC.) Cogn.	Ch	Zoo	14,498	1194	Na	14	Camargo et al. 2009
Leandra xanthocoma (Naudin) Cogn.	Ch	Zoo	14,800	1310	Na	15	Camargo et al. 2009
Miconia cinerascens Miq.	Ph	Zoo	18,273	1280	Na	04	Goldenberg 2004
Miconia hyemalis A.St.-Hil & Naudin	Ph	Zoo	19,792	1867	Na	17	Goldenberg 2004
Miconia sellowiana Naudin	Ph	Zoo	14,500	1191	Na	17	Goldenberg 2004
Tibouchina debilis Cogn.	Ch	Ane	18,274	1549	Na	11/13	Meyer et al. 2010
Tibouchina dubia Cogn.	Ch	Ane	18,733	1501	Na	10	Meyer et al. 2010
Tibouchina frigidula (DC.) Cogn.	Ch	Ane	14,808	1516	Na	10	Meyer et al. 2010
Tibouchina gracilis (Bonpl.) Cogn.	Ch	Ane	14,468	1416	Na	10	Meyer et al. 2010
Tibouchina hatschbachii Wurdack	Ph	Ane	18,281	1256	Na	15	Meyer et al. 2010
Tibouchina martialis (Cham.) Cogn.	Ph	Ane	14,807	1241	Na	04	Meyer et al. 2010
Meliaceae							
Cabralea canjerana (Vell.) Mart.	Ph	Zoo	*	-	Na	22	Pastore 2003
Monimiaceae							
Mollinedia clavigera Tul.	Ph	Zoo	9,263	1650	Na	14	Peixoto 2002
Moraceae							
Dorstenia brasiliensis Lam.	G	Zoo	14,666	63	Na	10	Boeni and Singer 2015
Myrtaceae							
Calyptranthes concinna DC.	Ph	Zoo	14,519	1216	Na	04	Vieira 2010, Rosa 2015
Campomanesia adamantium (Cambess.) O.Berg	Ph	Zoo	18,682	1365	Na	13	Lima et al. 2011
Campomanesia aurea O.Berg	Ph	Zoo	13,988	57	Na	10	Berg 1857
Campomanesia pubescens O.Berg	Ph	Zoo	14,797	1450	Na, ER (PR)	13	Lima et al. 2011
Campomanesia xanthocarpa O.Berg	Ph	Zoo	18,278	1646	Na	04	Lima et al. 2011

Table 1. *Continued.*

Families, species	L-F	DS	Voucher	Coll.	C	Location	Reference
Eucalyptus sp.	Ph	Aut	13,967	1555	Al, In	17	-
Eugenia handroana D.Legrand	Ph	Zoo	18,678	1663	Na	14	Sobral 2011
Eugenia punicifolia (Kunth) DC.	Ph	Zoo	13,973	1370	Na	10	Faria Junior 2010, Sobral 2011
Eugenia pyriformis Cambess.	Ph	Zoo	13,971	1209	Na	10	Romagnolo and Souza 2006, Sobral 2011
Myrcia guianensis (Aubl.) DC.	Ph	Zoo	14,520	1287	Na	04	Rosa and Romero 2012, Bezerra 2013
Myrcia hartwegiana (O.Berg.) Kiaersk.	Ph	Zoo	18,679	1681	Na	11	Rosa and Romero 2012
Myrcia multiflora (Lam.) DC.	Ph	Zoo	18,611	1482	Na	22	Rosa and Romero 2012, Lima et al. 2015
Myrcia palustris DC.	Ph	Zoo	13,975	1401	Na	04	Lima et al. 2015
Myrcia pulchra Kiaersk.	Ph	Zoo	13,969	1733	Na	22	Rosa and Romero 2012
Myrcia retorta Cambess.	Ph	Zoo	18,279	1403	Na	04	Rosa and Romero 2012
Myrcia splendens (Sw.) DC.	Ph	Zoo	13,985	1396	Na	04	Rosa and Romero 2012
Myrciaria delicatula (DC.) O.Berg.	Ph	Zoo	14,216	1743	Na	04/22	Vieira 2010
Psidium australe Cambess.	Ch	Zoo	13,987	71	Na	10	Sobral et al. 2015
Psidium cattleianum Sabine	Ph	Zoo	14,506	1466	Na	13	Vieira 2010, Lima et al. 2015
Psidium grandifolium Mart. ex DC.	Ph	Zoo	14,515	1449	Na	13	Legrand and Klein 1977
Myrtaceae sp. 1	Ph	Zoo	13,977	1438	Na	10	-
Myrtaceae sp. 2	Ph	Zoo	13,976	1597	Na	17	-
Ochnaceae							
Sauvagesia racemosa A.St.-Hil	H	Aut	14,682	1456	Na	10	Salvador et al. 2010
Onagraceae							
Fuchsia regia (Vell.) Munz	L	Zoo	14,680	1749	Na	13	Rodrigues and Singer 2014
Orchidaceae							
Acianthera sonderiana (Rchb.F) Pridgeon & M.W.Chase	E	Ane	14,675	1332	Na	22	Gonçalves and Waechter 2011
Epidendrum secundum Jacq.	Ch	Ane	18,615	87	Na	10	Stancik et al. 2009, Pessoa and Alves 2014
Gomesa recurva R.Br.	E	Ane	14,677	1180	Na	11	Barros et al. 2015a
Gomesa uniflora (Booth ex Lindl.) M.W.Chase & N.H.Williams	E	Ane	14,676	1481	Na	15	Barros et al. 2015b
Sauroglossum nitidum (Vell.) Schltr.	E	Ane	14,678	1360	Na	22	Heberle et al. 2012
Oxalidaceae							
Oxalis conorrhiza Jacq.	G	Aut	14,685	18	Na	21	Fiaschi and Conceição 2005
Oxalis hispidula Zucc.	G	Aut	14,734	6	Na	10	Cervi et al. 1988
Passifloraceae							
Passiflora amethystina J.C.Mikan	L	Zoo	14,827	1558	Na	10	Bernacci et al. 2003
Piperaceae							
Peperomia barbarana C.DC.	H	Zoo	17,278	1651	Na	14	Guimarães et al. 1984
Peperomia catharinae Miq.	H	Zoo	13,902	1179	Na	11	Guimarães and Carvalho-Silva 2012
Peperomia glabella (Sw.) A.Dietr. var. *glabella*	E	Zoo	17,280	1586	Na	14	Guimarães et al. 1984
Piper gaudichaudianum Kunth	Ph	Zoo	14,829	1655	Na	14	Guimarães and Carvalho-Silva 2012
Plantaginaceae							
Plantago guilleminiana Decne.	G	Aut	14,748	22	Na	13	Souza and Souza 2002, Hassemer 2016
Plantago tomentosa Lam.	G	Aut	19,757	1855	Na, We	13	Souza and Souza 2002, Moreira and Bragança 2011, Hassemer 2016
Poaceae							
Andropogon leucostachyus Kunth	H	Ane	18,104	1418	Na, Tr	10	Dias-Melo et al. 2009, Maciel and Silva 2011, Zanin and Longhi-Wagner 2011
Anthaenantia lanata (Kunth) Benth.	H	Aut	18,105	1613	Na	10	Renvoize 1988
Aristida pallens Cav.	H	Ane	17,361	1393	Na	13	Smith and Wasshausen 1982
Axonopus brasiliensis (Spreng.) Kuhlm.	H	Aut	18,112	73	Na	06/10	Smith and Wasshausen 1982
Axonopus marginatus (Trin.) Chase	H	Aut	18,283	1860	Na	10	Renvoize 1988
Cenchrus purpureus (Schumach.) Morrone	H	Aut	18,097	1725	Na	10/13	Renvoize 1988
Chascolytrum calotheca (Trin.) Essi. Longhi-Wagner & Souza-Chies	H	Aut	18,115	1610	Na	10	Renvoize 1988
Chloris gayana Kunth	H	Aut	17,363	1437	Al, In	06/13	Renvoize 1988, Moreira and Bragança 2011, Maciel et al. 2013
Dichanthelium sabulorum (Lam.) Gould & C.A.Clark	H	Aut	18,114	1539	Na	13	Renvoize 1988
Elionurus muticus (Spreng.) Kuntze	H	Aut	18,109	1616	Na, Tr	10	Renvoize 1988
Eragrostis airoides Nees	H	Aut	18,108	1605	Al, We	10/13	Moreira and Bragança 2011
Eragrostis neesii Trin.	H	Aut	18,111	1420	Na, Tr	10	Renvoize 1988
Megathyrsus maximus (Jacq.) B.K.Simon & S.W.L.Jacobs	H	Aut	14,083	1292	Al, In	13	Moreira and Bragança 2011
Melinis repens (Willd.) Zizka	H	Aut	18,106	1739	Al, We	13	Moreira and Bragança 2011
Merostachys multiramea Hack	G	Aut	*	-	Na, Tr	06/13	Smith and Wasshausen 1982
Ocellochloa stolonifera (Poir.) Zuloaga & Morrone	H	Aut	14,082	1505	Na	10	Sede et al. 2009
Paspalum cordatum Hack.	H	Aut	18,568	1526	Na	13	Renvoize 1988
Paspalum plicatulum Michx.	H	Aut	18,101	1447	Na, Tr	10	Smith and Wasshausen 1982
Paspalum polyphyllum Nees ex. Trin.	H	Aut	18,099	1546	Na	06/10	Dias-Melo et al. 2009, Silva 2013

Table 1. *Continued.*

Families, species	L-F	DS	Voucher	Coll.	C	Location	Reference
Piptochaetium montevidense (Spreng.) Parodi	H	Aut	17,362	1374	Na	13	Smith and Wasshausen 1982
Saccharum villosum Steud.	H	Ane	18,100	1594	Na	21	Smith and Wasshausen 1982
Schizachyrium condensatum (Kunth) Nees	H	Ane	17,360	1293	Na, Tr	13	Smith and Wasshausen 1982
Setaria sphacelata (Schumach.) M.B.Moss ex Stapf & C.E.Hubb.	H	Aut	17,359	1508	Na	10/13	Smith and Wasshausen 1982
Trachypogon spicatus (Lf.) Kuntze	H	Ane	17,364	1506	Na	06/13	Renvoize 1988
Urochloa decumbens (Stapf) R.D.Webster	Th	Aut	19,313	1868	Al, We	10/13	Moreira and Bragança 2011
Poaceae sp. 1	H	Aut	18,113	67	Na	10	-
Polygalaceae							
Monnina cardiocarpa A.St.-Hil & Moq.	H	Ane	18,120	1307	Na	10	Lüdtke et al. 2009
Polygala cyparissias A.St.-Hil & Moq.	Ch	Aut	14,601	1257	Na	19	Marques and Gomes 2002
Primulaceae							
Myrsine coriacea (Sw.) R.Br. ex Roem. & Schult.	Ph	Zoo	18,228	1734	Na	13/21	Jung-Mendaçolli et al. 2005
Myrsine umbellata Mart.	Ph	Zoo	18,233	1171	Na	04	Jung-Mendaçolli et al. 2005
Rhamnaceae							
Rhamnus sphaerosperma Sw. var. *pubescens* (Reissek) M.C.Johnst.	Ph	Zoo	14,561	1344	Na	11/17	Lima 2006, 2011
Rosaceae							
Acaena eupatoria Cham. & Schltdl.	Ch	Zoo	18,619	1342	Na	10	Kiejama and Bianchini 2003
Prunus myrtifolia (L.) Urb.	Ph	Zoo	14,569	1166	Na	11/15	Kiejama and Bianchini 2003
Rubus brasiliensis Mart.	Ph	Zoo	14,564	1165	Na, Tr	17	Kiejama and Bianchini 2003
Rubus urticifolius Poir.	Ph	Zoo	14,565	1267	Na		Kiejama and Bianchini 2003
Rubiaceae							
Borreria latifolia (Aubl.) K.Schum.	Th	Aut	14,885	1548	Na, We	13	Bacigalupo and Cabral 2007
Borreria paranaensis E.L.Cabral & Bacigalupo	Th	Aut	14,884	55	Na	10/13	Bacigalupo and Cabral 2007
Borreria poaya DC.	Th	Aut	14,886	1345	Na	19	Bacigalupo and Cabral 2007, Zappi et al. 2014
Borreria verticillata (L.) G.Mey.	Th	Aut	17,676	12	Na, We	06	Bacigalupo and Cabral 2007, Moreira and Bragança 2011
Coccocypselum lanceolatum (Ruiz & Pav.) Pers.	H	Zoo	14,792	1357	Na	13/15	Costa and Mamede 2007
Cordiera concolor (Cham.) Kuntze	Ph	Zoo	14,880	1732	Na	15	Zappi 2007
Coussarea contracta (Walp.) Müll.Arg.	Ph	Zoo	19,315	1856	Na	22	Gomes 2007
Galianthe elegans E.L.Cabral	G	Zoo	14,906	1326	Na	22	Cabral and Salas 2015
Galianthe verbenoides (Cham. & Schltdl.) Griseb.	G	Zoo	14,888	1477	Na	10	Cabral 2009
Galium hypocarpium (L.) Endl. ex Griseb.	Ch	Zoo	17,394	1598	Na	17	Jung-Mendoçolli and Cabral 2007, Moreira and Bragança 2011
Palicourea australis C.M.Taylor	Ph	Zoo	14,892	1411	Na	04	Ferreira Junior and Vieira 2015
Palicourea rigida Kunth	Ch	Zoo	14,895	1422	Na	10	Taylor 2007
Psychotria brachypoda (Müll.Arg.) Britton	Ph	Zoo	14,894	1582	Na	14	Taylor 2007
Psychotria suterella Müll.Arg.	Ph	Zoo	14,881	1656	Na	14	Taylor 2007
Psychotria vellosiana Benth.	Ph	Zoo	19,828	1816	Na	22	Taylor 2007
Rudgea parquioides (Cham.) Müll.Arg.	Ph	Zoo	14,896	1397	Na	04	Zappi 2007
Rutaceae							
Esenbeckia grandiflora Mart.	Ph	Aut	13,797	1181	Na	14	Pirani 2002
Zanthoxylum rhoifolium Lam.	Ph	Zoo	*	-	Na	22	Pirani 2002
Salicaceae							
Casearia decandra Jacq.	Ph	Zoo	19,820	1661	Na	15/17	Torres and Ramos 2007
Casearia lasiophylla Eichler	Ph	Zoo	14,018	1225	Na	21	Torres and Ramos 2007
Casearia sylvestris Sw.	Ph	Zoo	14,016	1250	Na	14/21	Torres and Ramos 2007
Sapindaceae							
Matayba elaeagnoides Radlk.	Ph	Zoo	14,458	1471	Na	22	Ferrucci et al. 2009
Scrophulariaceae							
Buddleja stachyoides Cham. & Schltdl.	H	Aut	14,503	1248	Na, We	10	Moreira and Bragança 2011
Smilacaceae							
Smilax brasiliensis Spreng.	L	Zoo	17,711	1745	Na, Tr	22	Andreata 2003
Solanaceae							
Calibrachoa heterophylla (Sendtn.) Wijsman	Ch	Aut	19,770	1857	Na	10	Smith and Downs 1966
Calibrachoa paranensis (Dusén) Wijsman	Ch	Aut	14,489	1231	Na	13	Stehmann et al. 2015
Solanum americanum Mill.	Ch	Zoo	17,756	1222	Na, We	17	Moreira and Bragança 2011
Solanum granulosoleprosum Dunal	Ch	Zoo	6,482	1652	Na	14/18	Moreira and Bragança 2011
Solanum hirtellum (Spreng.) Hassl.	Ch	Zoo	14,488	1327	Na	15	Smith and Downs 1966
Solanum inodorum Vell.	L	Zoo	17,761	1488	Na	22	Smith and Downs 1966
Solanum pseudocapsicum L.	Ph	Zoo	14,824	1402	Na, We	04	Smith and Downs 1966
Solanum pseudoquina A.St.-Hil.	Ph	Zoo	14,486	1644	Na	04	Feliciano and Salimena 2011
Solanum variabile Mart.	Ph	Zoo	19,317	1858	Na	22	Smith and Downs 1966
Symplocaceae							
Symplocos tenuifolia Brand	Ph	Zoo	19,314	1859	Na	22	Aranha-Filho et al. 2007
Thymelaeaceae							
Daphnopsis fasciculata (Meisn.) Nevling	Ph	Zoo	17,351	1221	Na	17	Rossi 2005
Verbenaceae							
Lantana camara L.	Ph	Zoo	13,602	3	Na, Tr	13/15	Moreira and Bragança 2011
Lantana fucata Lindl.	H	Zoo	14,764	1669	Na, Tr	13/15/17	Moreira and Bragança 2011, Silva and Lima 2012

Table 1. *Continued.*

Families, species	L-F	DS	Voucher	Coll.	C	Location	Reference
Lantana montevidensis (Spreng.) Briq.	H	Zoo	18,214	1730	Na	10	Silva and Salimena 2015
Lippia lupulina Cham.	H	Aut	13,600	1413	Na	04	Múlgura et al. 2003
Verbena hirta Spreng.	Ch	Zoo	18,738	36	Na	10	Thode and O'Leary 2015
Verbena sp.	Ch	Unk	13,591	1311	Na	15	-
Vivianaceae							
Viviania albiflora (Cambess.) Reiche	H	Aut	17,765	1215	Na	04	Ferreira et al. 2016
Winteraceae							
Drimys brasiliensis Miers	Ph	Zoo	18,223	1199	Na	13	Trinta and Santos 1997
Xyridaceae							
Xyris reitzii L.B.Sm. & Downs	G	Ane	18,226	1297	Na	8	Lozano 2016
Indeterminates							
Sp. 1	Unk	Unk	14,778	1738	Na	10	-
Sp. 2	Unk	Unk	17,575	1188	Na	11	-
Sp. 3	Unk	Unk	18,735	1536	Na	10	-
Sp. 4	Unk	Unk	17,213	1626	Na	10	-

Results

In Furnas Gêmeas we found 313 species belonging to 192 genera; (70 angiosperm families and 2 gymnosperm families are represented (Table 1). Just 4 angiosperm taxa were not identified to a species–level taxon. Asteraceae was the richest family, with 58 species, followed by Poaceae (26 spp.), Myrtaceae (22 spp.), Fabaceae (19 spp.), Rubiaceae (16 spp.), Melastomataceae (14 spp.), and Cyperaceae (10 spp.). These families together compound 52.6% of the total species.

The most diverse genera were *Baccharis* L. with 12 species, *Myrcia* DC. and *Solanum* L. with 7 species each, *Tibouchina* Aubl. with 6 species, and *Mimosa* L. with 5 species, accounting for 11.8% of the total species. Genera with single species represented 42.4% of the total (with 2 species = 10.8%; with 3 or 4 species = 6.7%).

Both chamaephytes and phanerophytes predominate in the study area, with 87 species each (27.6%), followed by hemicryptophytes (68 spp./21.6%), geophytes (38 spp./12.7%), therophytes (14 spp./4.4%), lianas (13 spp./4.1%), epiphytes (5 spp./1.6%), and parasites (1 sp., *Cuscuta racemosa* Mart. (von Martius 1823: 286)).

Among the dispersion syndromes, zoochoric forms totaled 116 species (36.4%) and autochoric and anemochoric forms tototaled 96 species each (31.0%). Five species remain unknown: *Verbena* sp., and the four taxa that have not been determined (1.6%).

The native flora amounted to 308 species, including transformers (22 spp.) and weeds (22 spp.) and 1 native invasive, *Gamochaeta purpurea* (L.) Cabrera (Linné 1753: 854, Cabrera 1961: 377). Among the alien species, 5 are invasive (*Cirsium vulgare* (Savi) Ten. (Savi 1798: 241, Tenore 1835–36: 209), *Chloris gayana* Kunth (Kunth 1830: 58), *Megathyrsus maximus* (Jacq.) B.K.Simon & S.W.L.Jacobs (von Jacquin 1781: 2, Simon and Jacobs 2003: 572), and *Eucalyptus* L'Hér., and *Pinus* L.) and four are weeds (*Cyperus esculentus* L. (Linné 1753: 45), *Eragrostis airoides* Nees (Nees 1829: 509), *Melinis repens* (Willd.) Zizka (Willdenow 1797: 322, Zizka 1988: 55), and *Urochloa decumbens* (Stapf) R.D.Webster (Stapf 1919: 528, Webster 1988: 391)).

According to official list of threatened species in Brazil (MMA 2014), we found *Araucaria angustifolia* (Bertol.) Kuntze (Bertoloni 1819: 411, Kuntze 1898: 375), *Xyris reitzii* L.B.Sm. & Downs (Smith and Downs 1960: 255), *Hippeastrum psittacinum* Herb. (Herbert 1821: 31) in the Endangered category (MMA 2014) and *Byrsonima brachybotrya* Nied (Niedenzu 1897: 206) in the Vulverable category. Five species are present in the list of threatened species of the state of Paraná (Paraná 1995), *Parodia carambeiensis* (Buining & Brederoo) Hofacker (Buining and Brederoo 1973: 1, Hofacker 1998: 11) as endemic and four classified as rare: *Campomanesia pubescens* O.Berg (Berg 1857: 443), *Halimium brasiliense* Grosser (Grosser 1903: 45), *Mandevilla coccinea* (Hook. & Arn.) Woodson (Hooker and Arnott 1834: 286, Woodson 1933: 734) and *Ruellia multifolia* (Nees) Lindau (Nees 1847: 33, Lindau 1895: 310).

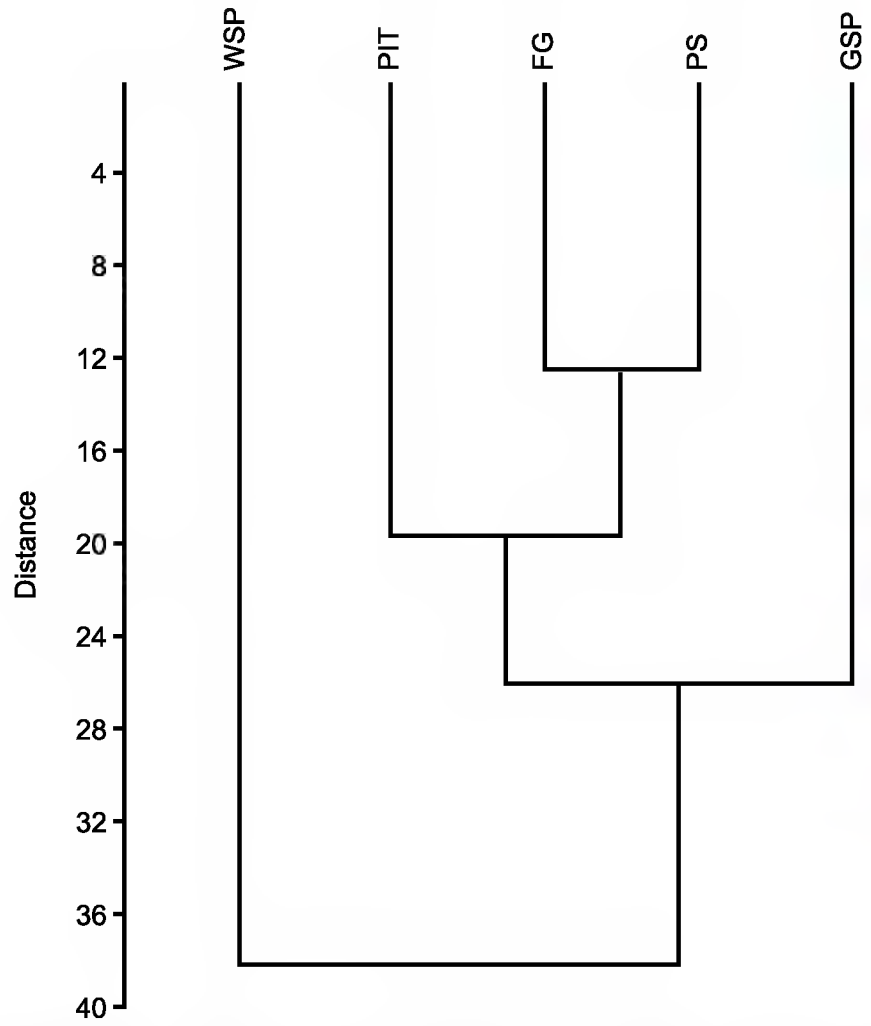
A comparative analysis between FG and the reference areas shows considerable similarity between them, except for Vila Velha State Park. The Furnas Gêmeas and Piraí da Serra areas show of the greatest similarity (Fig. 4).

Amaryllidaceae

***Hippeastrum psittacinum* Herb.** (Herbert 1821: 31) (Fig. 5A): bulbous herb; leaf lamina 34.7–46.0 × 2.7–3.0 cm, lanceolate; 2-flower inflorescence; tepals with red lateral borders presenting grooves or darker red reticles, cream-yellow base green-yellow; loculicidal capsule fruit (Amaral 2007).

Arecaceae

***Allagoptera campestris* (Mart.) Kuntze** (von Martius 1826: 109, Kuntze 1891: 726) (Fig. 5B): subshrub with underground stem; pinatipartite leaves, leaf lamina 65–88 cm long, emerging from the soil; leaf segments 42–46 pairs, arranged in 2 planes, lanceolate; inflorescence spike; 2 pedunculate bracts, persistent; sessile flowers, pistilate and staminate in the same inflorescence; obovate drupe fruit, yellowish-green when mature (Caxambú et al. 2015).



Figures 4. Cluster Analysis of a 1,782 grasslands taxa matrix of FG and its surroundings. VVSP (Vila Velha State Park); PIT (Pitangui Valley); FG (Furnas Gêmeas); PS (Piraí da Serra); GSP (Guartelá State Park).

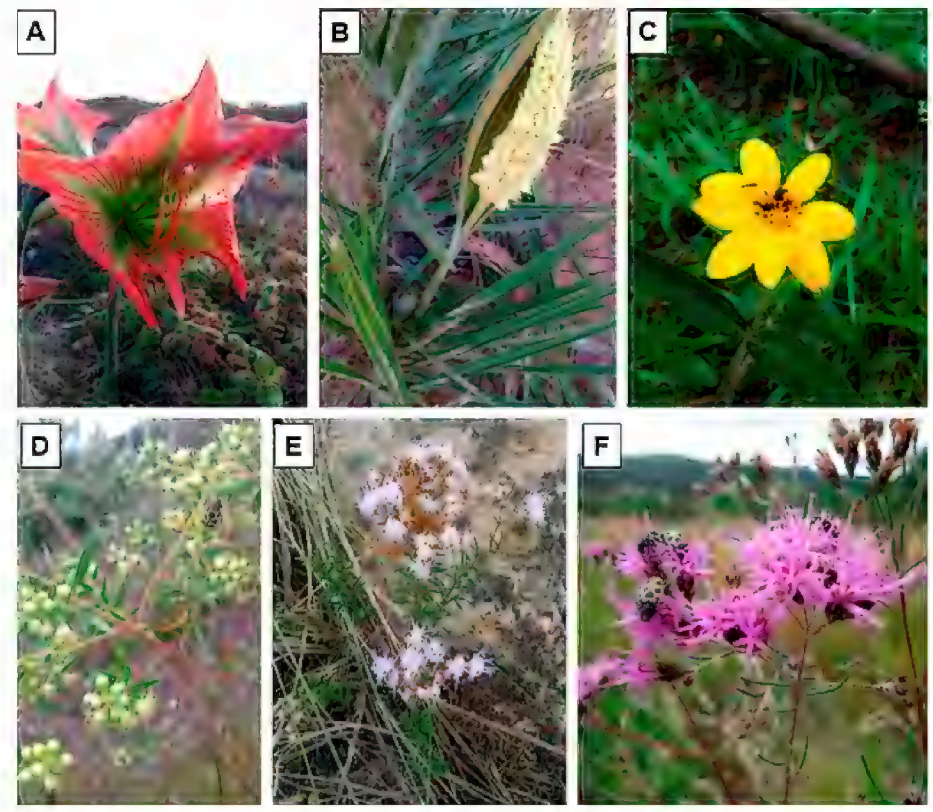


Figure 5. Some plant species found in the Furnas Gêmeas, Campos Gerais National Park, Paraná state, Brazil. Amaryllidaceaea: **A.** *Hippeastrum psittacinum*. Arecaceae: **B.** *Allagoptera campestris*. Asteraceae: **C.** *Aspilia montevidensis*. **D.** *Baccharis dracunculifolia*. **E.** *Chromolaena palmaris*. **F.** *Vernonanthura nudiflora.*

Asteraceae

***Aspilia montevidensis* (Spreng.) Kuntze** (Sprengel 1826: 578, Kuntze 1898: 129) (Fig. 5C): decumbent herb or ascending branches, hairy; leaf lamina 2.0–9.5 × 0.4–1.8 cm, linear-lanceolate, lanceolate or elliptic, opposite; solitary terminal capitulum; campanulate involucre, with involucred bracts in 2 series; yellow ligules; cypsela fruit variably, hairy, pappus usually biaristate, palease oblong to oblong-lanceolate (Santos 1984).

***Baccharis dracunculifolia* DC.** (De Candolle 1836: 421) (Fig. 5D): subshrub and shrub, dioecious; leaf lamina 8–35 × 2–9 mm, linear-lanceolate to lanceolate, toothed margins and acute base; capitula discoid staminate, pedunculate, long cobs; campanulate envelope, bracts involucred 4-serial, receptacle plane, glabrous; creams corolla; cypsela abortive, setose pappus; capitula discoid pistilate, long pedunculate, spike; campanulate envelope, bracts involucral 4-serial; creams corolla, filiform; cypsela fusiform; setose pappus (Moraes 1997, Hattori and Nakajima 2008).

***Chromolaena palmaris* (Sch.Bip ex Baker) R.M.King & H.Rob** (Schultz 1876: 294, King and Robinson 1970: 204) (Fig. 5E): subshrub with xylopodium; leaf lamina 0.8–1.5 × 0.1–0.2 cm, linear-lanceolate, glabrous or sparsely pubescent; capitula arranged in corymbose filiform pedicels; cylindrical-campanulate 5-serial bracts, gradually shorter to exterior, all subacute and curtly peaked at the apex with 3 grooves on the back; purple corolla; fruits slightly pubescent, white pappus (Cabrera and Klein 1980).

***Vernonanthura nudiflora* (Less) H.Rob** (Lessing 1829: 258–259, Robinson 1992: 72) (Fig. 5F): herb with xylopodium; leaf lamina 6–10 × 0.1–0.15 cm, narrowly linear, glabrous on the ventral surface and poorly sericeous-pubescent on the dorsal surface; many corymbose capitula; campanulate involucre, tight filaria, arranged in 4 or 5 series, ovate-oblong, obtuse, lanuginous on the back; purple corolla 15–20; cylindrical cypsela fruit, costate, white pappus (Cabrera and Klein 1989).

Cactaceae

***Parodia carambeiensis* (Buining & Brederoo) Hofacker** (Buining and Brederoo 1973: 1, Hofacker 1998: 11) (Fig. 6A): rupicolous herb; green stems, unbranched; reduced leaves, modified in brown spines; areoles with 1–(2) flowers, apical; perianthed segments, yellow stamens and pistiles, pink stigmas; vinaceous elliptical berry fruit (Soller et al. 2014).

Commelinaceae

***Commelina villosa* (C.B.Clarke) C.B.Clarke ex Chodat & Hassl.** (Chodat and Hassler 1901: 438) (Fig. 6B): erect herb; stem hairy with red spots; oblong-narrow leaves, sessile; blue corolla; capsule fruit (Hassemer 2017).

Convolvulaceae

***Ipomoea delphinioides* Choisy** (Choisy 1858: 53) (Fig. 6C): prostrated herb; leaf lamina 4.5–9.0 × 2–6 cm, the entire 3 lobes, elliptical; summit, 1–5 flowers; bracts and bracteoles lanceolate; pink corolla, infundibuliform; capsule fruit (Ferreira 2009).

Fabaceae

***Chamaecrista rotundifolia* (Pers.) Greene** (Person 1805: 456, Greene 1899: 31) (Fig. 6D): decumbent to ascending herb; leaves with a pair of leaflets, short-

Figure 6. Some plant species found in the Furnas Gêmeas, Campos Gerais National Park, Paraná state, Brazil. Cactaceaea: **A.** *Parodia carambeiensis*. Commelinaceae: **B.** *Commelina villosa*. Convolvulaceae: **C.** *Ipomoea delphinioides*. Fabaceae: **D.** *Chamaecrista langsdorffii*. **E.** *Mimosa dolens* var. *acerba*. **F.** *Mimosa lanata*.

petiolate; stipules persistent, adpressed to the stem; leaflets obovate; racemes reduced to axillary fascicles; yellow corolla; fertile 5 stamens, sometimes with 1–3 staminodes reduced; erect legume fruit, linear-oblong, plane-compressed, straight to slightly falcate (Camargo and Miotto 2004, Dantas and Silva 2013).

Desmodium incanum **DC.** (De Candolle 1825: 332) (Fig. 7A, B): erect to prostrate herb; pinned-trifoliate leaves; stipules connate almost to the apex when young and entirely free in adult; leaflets obovate, orbicular or rarely ovate; racemes terminal; purple or violet corolla; lomentum fruit 4–6-articulate, pubescent (Andrade et al. 2009).

Eriosema heterophyllum **Benth.** (Bentham 1849: 520) (Fig. 7C): prostrate to decumbent herb; unifoliolate leaves; stipules connate; leaflets ovate-lanceolate, rarely suborbicular; racemes axillary; yellow corolla; ovate legume fruit (Andrade et al. 2009, Rogalski 2009).

Eriosema longifolium **Benth.** (Bentham 1849: 519) (Fig. 7D): erect herb; pinned-trifoliate leaves, unifoliolate at the base of the branches; stipules connate; linear to narrow-lanceolate leaflets, with yellow punctate glands; racemes axillary, globose; yellow corolla; ovate legume fruit (Andrade et al. 2009, Rogalski 2009).

Galactia boavista **(Vell.) Burk.** (Velloso 1829: 309, Burkart 1971: 783) (Fig. 7E): prostrate, ascending or erect herb; unifoliolate leaves; stipules free; elliptical, leaflets oblong, obovate, rarely ovate; racemes axillary, knobby; violet or pink corolla; straight legume fruit (Andrade et al. 2009, Ceolin 2011).

Mimosa dolens **var.** ***acerba*** **(Benth.) Barneby** (Bentham 1841: 378, Barneby 1991: 583) (Fig. 6F): scandent shrub; bipinnate leaves, petiolate; leaflets 12–20 pairs per pinna, lancet, strigose; inflorescence capituliform solitary, globose, axillary; pink stamens; sacellum fruit (Dutra 2009).

Mimosa lanata **Benth.** (Bentham 1841: 379) (Fig. 6E): subshrub; bipinnate leaves, sessile; leaflets 10–18 pairs per pinna, oblong; inflorescence capituliform, grouped in racemes, terminal; lilac stamens; craspedium fruit (Dutra 2009).

Zornia reticulata **Sm.** (Smith 1818: 77) (Fig. 7F): erect or prostrate herb; leaves with a pair of leaflets; stipules peltate; ovate-lanceolate lower leaflets, oblong-lanceolate upper leaflets; spike inflorescence, terminal or axillary; yellow corolla; lomentum fruit 6–8-articulated, straight, tomentose (Dutra et al. 2005, Andrade et al. 2009).

Melastomataceae

Lavoisiera pulchella **Cham.** (von Chamisso 1834: 370) (Fig. 8A): subshrub; young branches with pedunculate-stellate trichomes; petiole absent; leaf lamina 0.9–1.5 × 0.4–0.7 cm, oblong-lanceolate; terminal flowers, usually 6-mere; fillets with prolonged connective; ovary adnate to hypanthium; capsule fruit (Goldenberg et al. 2015).

Leandra aurea **Cogn.** (Cogniaux 1886: 142) (Fig. 8C): shrub; stem, branches, leaves and hypanthium densely velutinous-hairy and sparsely furfuraceous-starred; leaf lamina 4.5–12.0 × 2.5–6.5 cm, elliptic to lanceolate; inflorescence thyrsus, glomerulus; fillets with connective not extended; apex ovarian hairy; berry fruit (Camargo et al. 2009).

Miconia sellowiana **Naudin** (Naudin 1851: 206) (Fig. 8B): shrub; stem, branches, leaves and hypanthium sparsely coated with trichomes starring, later glabrescent; leaf lamina 4.5–12.0 × 1–3 cm, lanceolate to oblong-lanceolate; presence of domatia; terminal panicles; calyx with deciduous laciniae in fruit; fillet with prolonged connective; glabrous ovary; berry fruit (Goldenberg 2004).

Tibouchina gracilis **(Bonpl.) Cogn.** (Bonpland 1823: 138, Cogniaux 1885: 386) (Fig. 8D): subshrub; petiole absent, leaf lamina 2.3–11.5 × 0.6–3.0 cm, elliptic or lan-

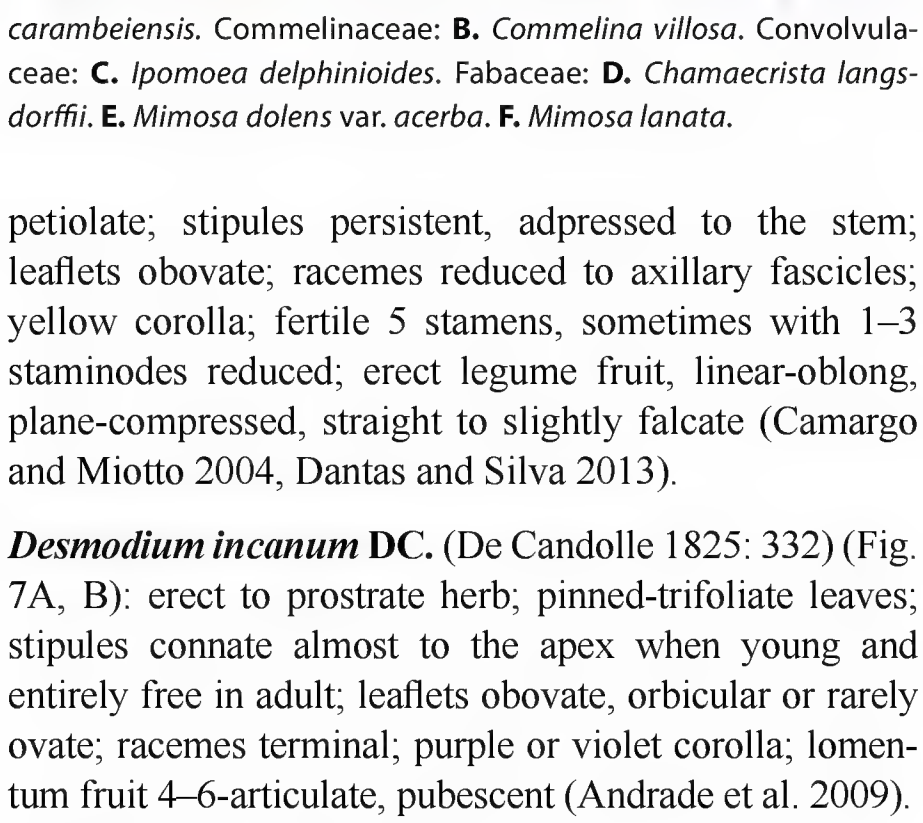


Figure 7. Some plant species found in the Furnas Gêmeas, Campos Gerais National Park, Paraná state, Brazil. Fabaceae: **A–B.** *Desmodium incanum*. **C.** *Eriosema heterophyllum*. **D.** *Eriosema longifolium*. **E.** *Galactia boavista*. **F.** *Zornia reticulata*.

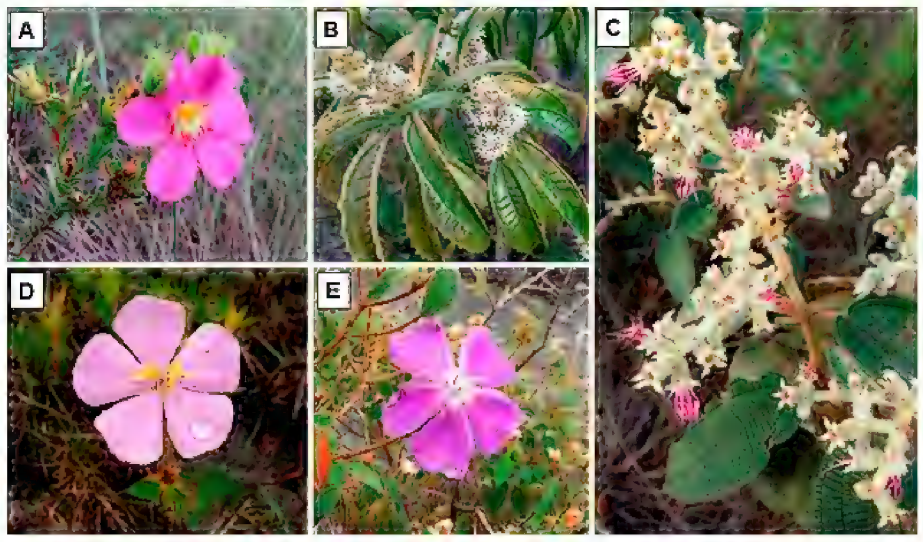


Figure 8. Some plant species found in the Furnas Gêmeas, Campos Gerais National Park, Paraná state, Brazil. Melastomataceae: **A.** *Lavoisiera pulchella*. **B.** *Miconia sellowiana*. **C.** *Leandra aurea*. **D.** *Tibouchina gracilis*. **E.** *Tibouchina hatschbachii*.

ceolate; inflorescence thyrsus, 9–27 flowers, congested; bracteoles early deciduous; calyx with persistent laciniae in fruits; glabrous fillets with prolonged connective; ovary with apex densely sericeous; capsule fruit (Meyer et al. 2010).

***Tibouchina hatschbachii* Wurdack** (Wurdack 1963: 1) (Fig. 8E): shrubs; leaf lamina 1.6–5.5 × 1.2–3.4 cm, oval; solitary flowers; bracteoles persistent for a long time in bloom, located in hypanthium base; calyx with laciniae fallen in fruit; fillets with prolonged connective, moderately glandule-setose; ovary glabrous, rare sparsely setose; capsule fruit (Meyer et al. 2010).

Myrtaceae

***Myrcia pulchra* Kiaersk.** (Kiaerskov 1893: 65) (Fig. 9A): shrubs; opposite leaves, discoulors, congested at the apex of the branches; leaf lamina 3.5–10.5 × 1.0–3.5 cm, elliptic to lanceolate, with translucent glands; panicles multiflora, subterminal; calyx 4-mere; white corolla; hypanthium prolonged above the ovary, externally glabrous; globose berry fruit (Rosa and Romero 2012).

***Psidium grandifolium* Mart. ex DC.** (De Candolle 1828: 234) (Fig. 9B): shrub; opposite leaves; leaf lamina 3.5–7.5 × 2.5–4.5 cm, obovate; calyx 5-mere, persistent; white corolla; globose or pear-shaped, berry fruit (Legrand and Klein 1977).

Orchidaceae

***Epidendrum secundum* Jacq.** (von Jacquin 1760: 29) (Fig. 10A): herb rupicolous; cylindrical stem; short rhizome; leaves 2.5–11.5 × 0.6–2.7 cm, distichous, ovate to lanceolate, leathery; inflorescence corymbose; sepals and petals pink to lilac; fusiform capsule fruit (Stancik et al. 2009, Pessoa and Alves 2014).

Poaceae

***Andropogon leucostachyus* Kunth** (Kunth 1816: 187) (Fig. 9C): perennial herb, caespitosus; ligule membranous; leaf lamina 6–52 × 0.1–0.4 cm, linear, glabrous; panicle with 2–6 branches; spikelets sessile, bisexual, usually aristate and spikelets pedicellate, rudimentary,

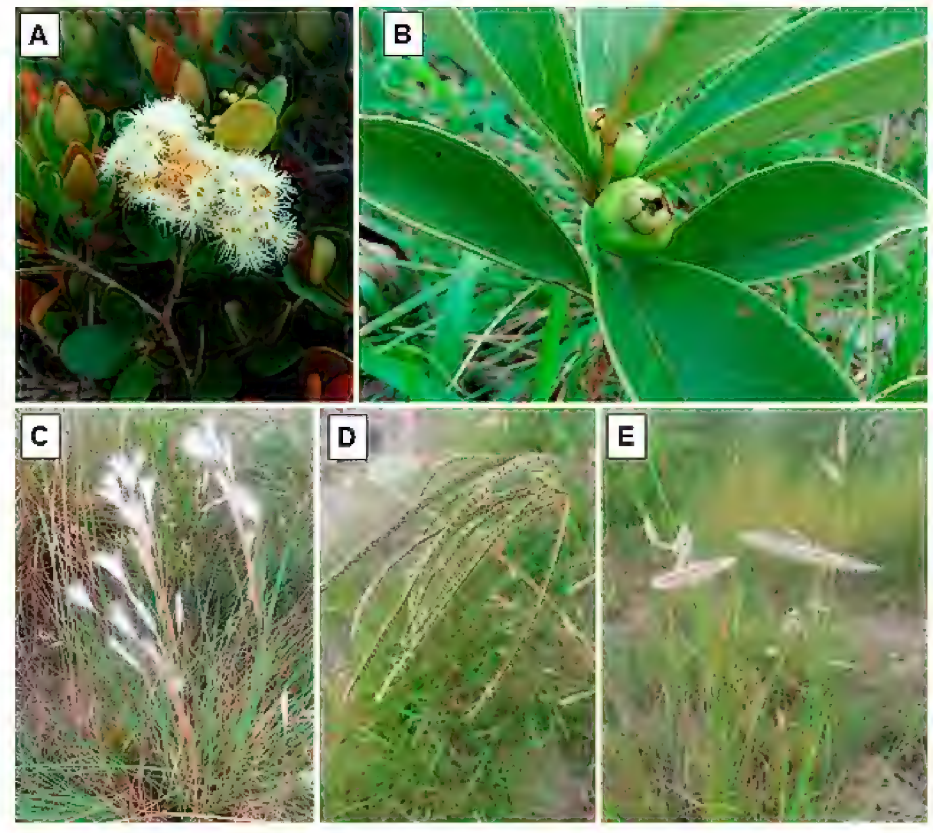


Figure 9. Some plant species found in the Furnas Gêmeas, Campos Gerais National Park, Paraná state, Brazil. Myrtaceae: **A.** *Myrcia pulchra*. **B.** *Psidium grandifolium*. Poaceae: **C.** *Andropogon leucostachyus*. **D.** *Chloris gayana*. **E.** *Paspalum polyphyllum*.

neutral, mutic or aristulate, shorter and narrower than the sessile spikelet; caryopsis fruit (Dias-Melo et al. 2009, Maciel and Silva 2011, Zanin and Longhi-Wagner 2011).

***Chloris gayana* Kunth** (Kunth 1830: 58) (Fig. 9D): perennial herb, forming dense clumps; glabra leaf sheath; ligule surrounded by a line of trichomes hispid; leaf lamina 15–30 × 0.2–0.4 cm, glabrous; panicle with 9–20 branches, spikelets with (2) 3–4 anthecium; glumes 1-nervate, glabrous; caryopsis fruit (Maciel et al. 2013).

***Paspalum polyphyllum* Nees ex. Trin.** (Trinius 1826: 114) (Fig. 9E): perennial herb, caespitosus; hairy apex in the leaf; ligule membranous; leaf lamina 2.2–9.0 × 0.2–0.5 cm, lanceolate, flat; inflorescence with 1–3 spikes, unilateral branches; spikelets binnary or solitary, ovate, gluma and lower palea absent; caryopsis fruit (Dias-Melo et al. 2009, Silva 2013).

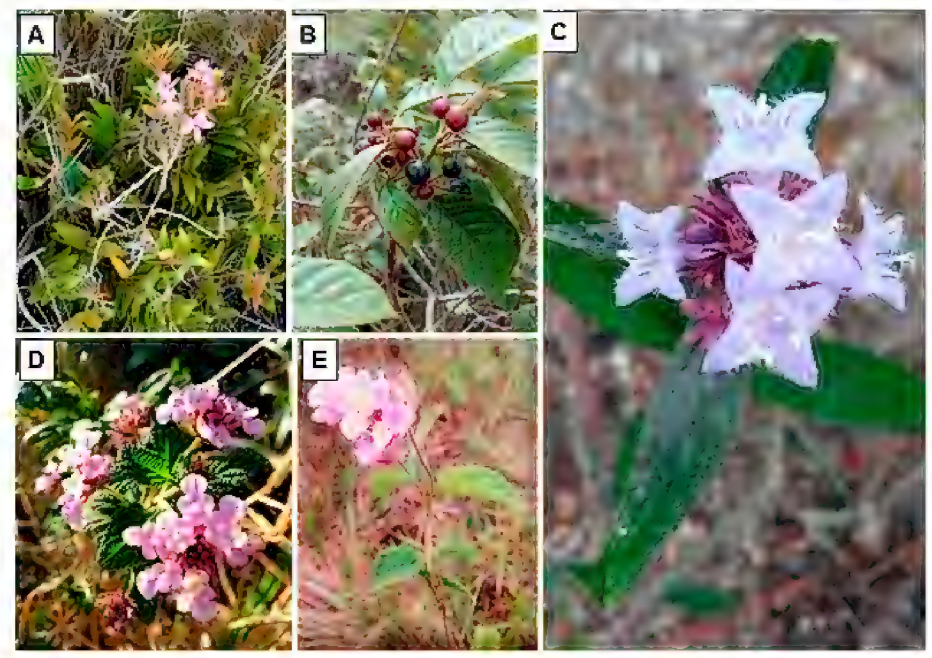


Figure 10. Some plant species found in the Furnas Gêmeas, Campos Gerais National Park, Paraná state, Brazil. Orchidaceae: **A.** *Epidendrum secundum*. Rhamnaceae: **B:** *Rhamnus sphaerosperma* var. *pubescens*. Rubiaceae: **C.** *Borreria poaya*. Verbenaceae: **D.** *Lantana fucata*. **E.** *Lippia lupulina*.

Rhamnaceae

***Rhamnus sphaerosperma* Sw. var. *pubescens* (Reissek) M.C.Johnst.** (Swartz 1788: 50, Reissek 1861: 91, Johnston 1971: 51) (Fig. 10B): shrub to tree; leaves alternate; leaf lamina 5–10 × 2.5–4.0 cm, elliptic; stipules subulate; flowers bisexual, slightly campanulate, pubescent; globose drupe fruit, suborbicular to orbicular, black (Lima 2006, 2011).

Rubiaceae

***Borreria poaya* DC.** (De Candolle 1830: 549) (Fig. 10C): erect or decumbent herb; square branches, glabrous; stipules semilunar, connate, persistent; opposite leaves, sessile; leaf lamina 2.5–4.0 × 1.0–1.5 cm, lanceolate, concolorous; flowers in dense glomerulus apical and axillary, subtended by 2 extended foliaceous bracts; corolla white to lilac; obovoid capsule fruit (Zappi et al. 2014).

Verbenaceae

***Lantana fucata* Lindl.** (Lindley 1824: 798) (Fig. 10D): shrubs; branches square, erect, decumbent, rare scandent without hooklets; leaf lamina 1.5–6.5 × 0.7–3.5 cm, elliptic, serrate margin, discolorous, papery; inflorescence corymbose; differentiated bracts in 2 wide-oval external and oval internal, persistent in fruit; lilac corolla; ovoid drupe fruit (Silva and Lima 2012).

***Lippia lupulina* Cham.** (von Chamisso 1832: 222) (Fig. 10E): subshrub; velutinous branches; leaf lamina 4–6 × 3–4 cm, oval, serrated edge; inflorescence spikes-capitula, globular, terminal; developed bracts broadly ovate or orbicular-cordate, membranous, colorful, covering the corolla; corolla externally pink and internally yellow; obovate drupe fruit (Múlgura et al. 2003).

Discussion

The vegetation of Furnas Gêmeas presents low species richness when compared to better-preserved areas in the Campos Gerais region (Carmo 2006, Cervi et al. 2007, Nanuncio and Moro 2008, Moro et al. 2012). Furthermore, invasive exotic species are common. This high level of biological contamination has severe implications for biodiversity and conservation of southern Brazilian grasslands (Ziller and Galvão 2002).

We found the high richness of Asteraceae, Poaceae, Myrtaceae, Fabaceae, Rubiaceae, Melastomataceae, and Cyperaceae. Several studies have pointed these families as having the larger number of taxa in the Campos Gerais region (Hatschbach and Moreira Filho 1972, Carmo 2006, Cervi et al. 2007, Nanuncio and Moro 2008, Dalazoana and Moro 2011, Moro et al. 2012, Silva et al. 2016), and therefore, we noticed that FG still retains part of its original flora.

Most of the weeds are native. Possibly favored by both wind dispersal and by frequent anthropogenic fires, they contribute to a highly resilient herbaceous community (Gómez-González et al. 2011). However, exotic species could out-compete the native species (Ziller 2000).

It is clear that in the Campos Gerais a remarkably varied habitat having high species richness. Although our survey studied just a small part of this fragmented landscape and our data are not exhaustive, these results are show the need for additional studies. Continued impacts may lead to increased biological contamination, eliminating native species and further degrading habitats. Priority must be given to the management of grassland areas to minimize anthropogenic pressures and to promote natural regeneration that will help conserve plant and animal species. FG harbors rare and threatened species that demand urgent conservation measures. We recommend that access to FG be closed as a way to prevent the advancement of invasive species.

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Authors' Contributions

ALPA, RSM and MRBC collected and analyzed the data; ALPA and MRBC wrote the text; ALPA, MRBC, RSM and YSK identified specimens; MRBC and RSM reviewed the final text.

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